Information-Theoretic Foundations of ISAC

Abstract: In a first part of this lecture, we provide an introduction to Shannon's famous channel coding theorem, as well as to the theory of optimal sensing systems (detection errors, distortion, etc.). We then show modern applications of these results for integrated sensing and communication (ISAC) systems. Specifically, we shall present the optimal capacity-distortion and capacity-detection error exponent tradeoffs for single-transmitter and single-receiver ISAC systems. The last part of the tutorial will cover extensions to network scenarios with multiple transmitters or multiple receivers. Specifically, for multiple transmitters we will present information-theoretic coding schemes that integrate collaborative sensing and collaborative communication into a single code construction with improved performances.